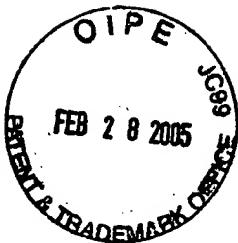


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AF/28378
TWW



Applicant: **William T. Turner**
Serial No.: **09/954,625**
Filed: **September 17, 2001**
Title: **PICKUP FOR ELECTRIC GUITARS AND METHOD OF
TRANSDUCING THE VIBRATION OF GUITAR STRINGS**
Art Unit: **2837**
Examiner: **David S. Warren**
Attorney File Reference: **12017-26/NEC**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPEAL BRIEF

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313

03/04/2005 TLUU11 00000028 501329 09954625
01 FC:1252 450.00 DA

**Introductory Comments
and
Petition for Extension of Time**

An OFFICE ACTION was issued April 26, 2004, in the subject application, which action was made final (hereinafter "the Office Action"). A NOTICE OF APPEAL with the requisite fee and extension of time was filed by appellant on October 26, 2004, the Office date of receipt of which by the Patent Office is October 29, 2004 [see M.P.E.P. § 1206].

Appellant hereby petitions the Commissioner for a two-month extension of time under 37 C.F.R. § 1.136(a) to file this APPEAL BRIEF [see 37 C.F.R. § 1.191(d)], thereby extending the two-month period of response outlined in 37 C.F.R. § 1.192(a) from December 29, 2004, to February 28, 2005. Payment for the \$450 fee under 37 C.F.R. § 1.17(a)(2) is attached.

Appellant hereby files this APPEAL BRIEF in triplicate. Payment for the \$500 fee set forth in 37 C.F.R. § 1.17(c) is attached. This APPEAL BRIEF sets forth the authorities and arguments on which appellant relies to maintain the appeal, and includes sections corresponding to each of the relevant subparagraphs outlined in 37 C.F.R. § 1.192(c).

03/04/2005 TLUU11 00000028 501329 09954625
02 FC:1402 500.00 DA

1. Real Party in Interest

The real party of interest in the subject application is Fender Musical Instruments Corporation.

2. Related Appeals and Interferences

There are no related appeals and interferences known to appellant or the appellant's agent of record.

3. Status of Claims

The status of the claims is as follows:

Claims 1–23: canceled; and

Claims 24–40: pending.

Each of the pending claims, i.e., claims 24–40, stands rejected and is on appeal in the application.

4. Status of Amendments

No amendment was filed after final rejection.

5. Summary of Invention

A copy set of the claims on appeal is included in Appendix A. The claims on appeal include five independent claims, namely, claims 24 and 37–40. All of the dependent claims 25–36 depend from claim 24.

This summary focuses on the independent claims and provides reference to the specification and the drawings of the application, including reference numerals. Reference is made to the specification of U.S. Published Application No. 2002/0092413 (i.e., the published application corresponding to the subject application), which is included in Appendix B.

Claim 24 and Dependent Claims

The invention as recited in claim 24 is directed to a pickup that includes a first wire coil 14, a second wire coil 15, a plurality of magnet pole pieces 12, and a ferromagnetic plate 17, which pickup is clearly shown in FIGS. 2 and 5 provided below (see ¶ 0032).

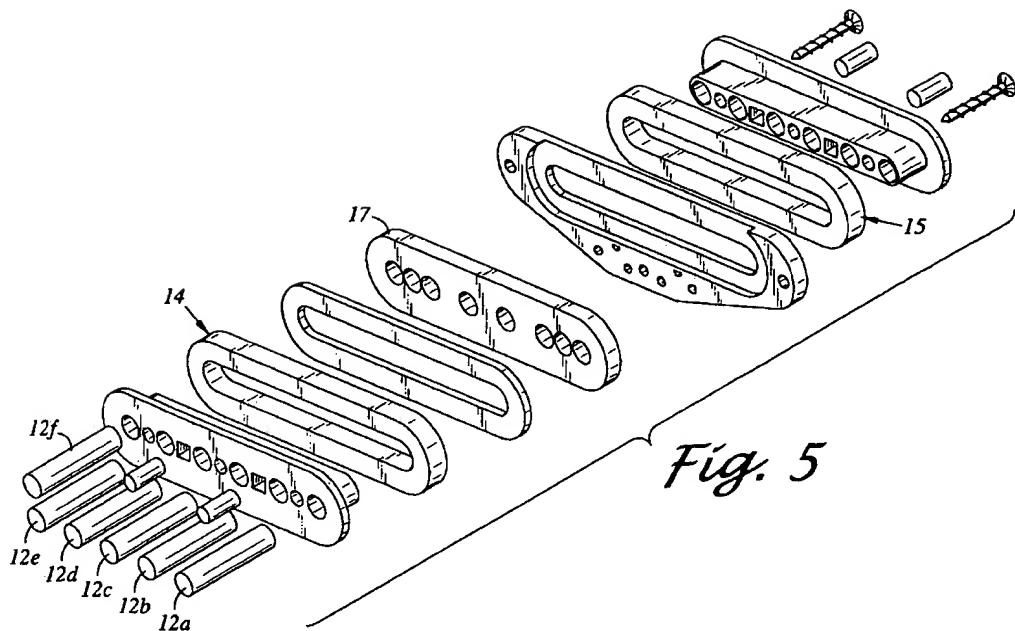


Fig. 5

The ferromagnetic plate 17 is disposed in a substantially magnetically neutral location between the wire coils 14 and 15 (see ¶ 0044).

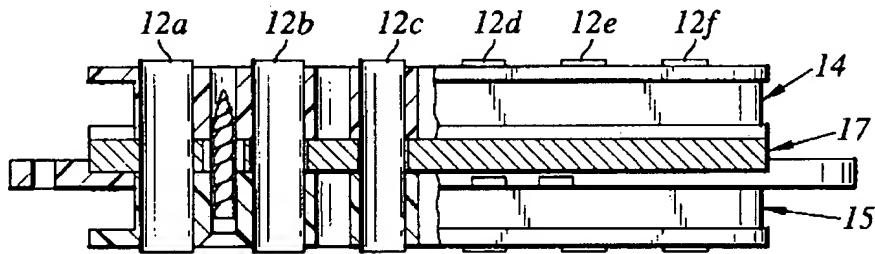


Fig. 2

The invention set forth in dependent claims 25–36 includes a number of features, including that:

- the ferromagnetic plate 17 generally separates magnetic lines of force of a north pole of the magnet pole pieces 12 from magnetic lines of force of a south pole of the magnetic pole pieces (see ¶ 0045);
- the ferromagnetic plate 17 is oriented substantially perpendicularly with respect to the magnet pole pieces 12 (see ¶ 0039);
- the ferromagnetic plate 17 is disposed substantially midway between opposite ends of the magnet pole pieces 12 (see ¶ 0044);

- the ferromagnetic plate 12 is a single, uniformly flat ferromagnetic plate (see FIGS. 2 and 5);
- the pickup can include bobbins 10 and 11 for the wire coil 14 and 15 (see ¶ 0033);
- the first wire coil 14 is disposed generally above the second wire coil 15 (see FIG. 2.);
- the wire coils 14 and 15 are substantially matched to one another and are oppositely wound (see ¶¶ 0051, 0053, and 0077);
- the ferromagnetic plate 56 does not connect to any ferromagnetic portion that extends upwardly or downwardly to the elevation of the end portions of the magnet pole pieces 12 (see ¶ 0065 and FIG. 2);
- the pickup 50 can include a pair of steel plates 64 attached to the bobbins 52 and 54 and not in contact with the ferromagnetic plate 56 (see ¶¶ 0070 and 0071 and FIGS. 9 and 10); and
- the ferromagnetic plate 17 has a thickness of between approximately 0.125 inch and approximately 0.187 inch or, alternatively, of at least 0.100 inch (see ¶ 0046).

Independent Claims 37–40

Similar to the invention recited in claim 24, the pickup of claim 37 includes bobbins 10 and 11 in addition to the coils 14 and 15 and the ferromagnetic plate 17 (see ¶ 0032 and FIGS. 2 and 5). In addition, the ferromagnetic plate 17 is disposed in a substantially magnetically neutral location between the wire coils (see ¶ 0044). Further, the wire coils are configured so as to create a humbucking effect (see ¶¶ 0053, 0064, 0067, and 0077).

The invention set forth in claim 38 is directed to a guitar 70 with a pickup as recited in claim 37 (see ¶ 0073 and FIG. 12).

Claim 39 recites a method invention for forming a pickup in which the bobbins 10 and 11 are provided with the wire coils 14 and 15 and in which the ferromagnetic plate 17 is positioned between the coils 14 and 15 such that the ferromagnetic plate 17 is disposed in a substantially magnetically neutral location therebetween (see ¶¶ 0032 and 0044 and FIGS. 2 and 5).

Lastly, in claim 40, a method for converting vibrations of strings of a musical instrument into electrical signals is provided in which a pickup with a ferromagnetic plate 17 is disposed

between two wire coils 14 and 15 on bobbins 10 and 11, with the two coils humbucking so as to mitigate noise (see ¶¶ 0053, 0064, 0067, and 0077).

6. Issues

Issue A: Whether claims 24–27, 29–33, 35, and 36 are patentable under 35 U.S.C. § 103(a) in view of the combination of U.S. Patent Nos. 3,657,461 to Freeman and 5,834,999 to Kinman.

Issue B: Whether claims 28 and 34 are patentable under 35 U.S.C. § 103(a) in view of the combination of U.S. Patent Nos. 3,657,461 to Freeman; 5,834,999 to Kinman; and 5,811,710 to Blucher et al.

Issue C: Whether claims 37–40 are patentable under 35 U.S.C. § 103(a) in view of U.S. Patent Nos. 3,657,461 to Freeman and 5,811,710 to Blucher et al.

7. Grouping of Claims

Claims 24 and 37–40 are independent claims, with claims 25–36 depending from claim 24. Based on the rejections outlined in the final Office Action, the claims may be grouped as follows:

Group I: claims 24–39; and

Group II: claim 40.

This grouping has been chosen as each of the claims of Group I include the limitation of a ferromagnetic plate disposed at a substantially magnetically neutral location between a pair of coils. Claim 40 does not include this limitation and is, therefore, grouped separately, which is discussed below.

8. Argument

Due to the nature of the rejections set forth in the Office Action, subparagraphs (i), (ii), (iii), and (v) of 37 C.F.R. § 1.192(c)(8) do not apply. Accordingly, each of the issues recited in Section 6 above will be addressed under 37 C.F.R. § 1.192(c)(8)(iv) only.

Issue A

Claims 24–27, 29–33, 35, and 36 stand rejected under 35 U.S.C. § 103(a) in view of the combination of U.S. Patent Nos. 3,657,461 to Freeman and 5,834,999 to Kinman. These rejections are respectfully traversed.

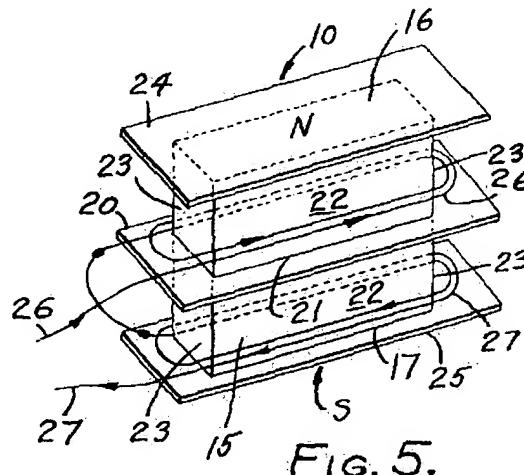
Claim 24

Focusing on the limitations recited in claim 1, a pickup includes a ferromagnetic plate disposed at a substantially magnetically neutral location between a pair of coils. This limitation is not shown or suggested by the cited patents, as discussed below.

Cited Patents

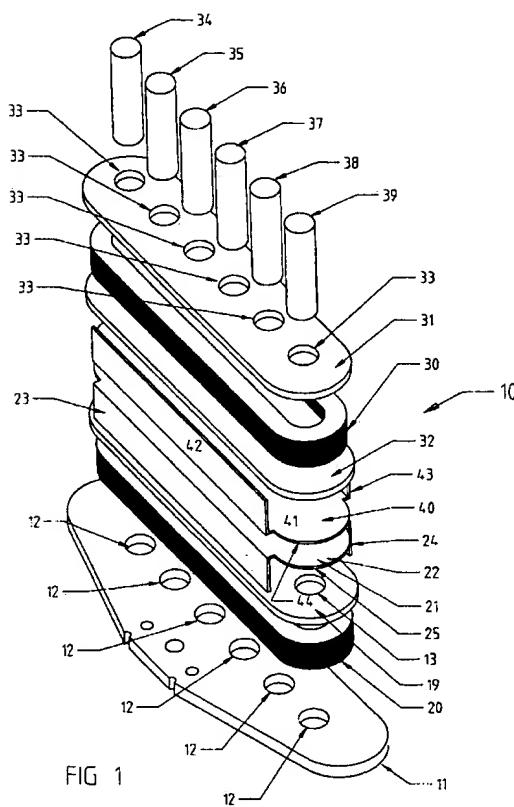
U.S. Patent No. 3,657,461 to Freeman shows a single pickup 10 with a magnet 15, a divider plate 20, and a fiber plates 24 and 25 (see column 2, lines 28–42 and FIG. 5). Freeman states that the divider plate 20 by being formed of magnetic material maintains the coil 26 in the flux of the north pole of the magnet 15 and the coil 27 in the flux of the south pole of the magnet 15 (see column 3, lines 67–71).

In contrast to the invention recited in the claims of the subject application, Freeman is silent as to positioning a ferromagnetic plate at a substantially magnetically neutral location between a pair of coils.



U.S. Patent No. 5,834,999 to Kinman shows a transducer 10 having magnetic pole pieces

34–39; a pair of coils 20 and 30 sandwiched between plates, and a pair of shields 21 and 40. Like Freemen, Kinman is silent as to positioning a ferromagnetic plate at a substantially magnetically neutral location between a pair of coils.



Errors in the Rejection

The primary error in the rejection of claim 24 is that the Patent Office does not establish a *prima facie* case of obviousness. More specifically, the Patent Office fails to provide one or more references that teach or suggest to combine or modify the references, with the combination or modification being sufficient to have made the claimed invention obvious to one skilled in the art.

In rejecting claim 24, the Office Action ignores the feature directed to a ferromagnetic plate disposed between a pair of coils at a substantially magnetically neutral location. The Office Action is completely silent with regard to this feature of the pickup of claim 24. It is possible that this silence stems from the fact that both the Freeman and the Kinman patent fail to teach or suggest a pickup in which a ferromagnetic plate is disposed between a pair of coils at a substantially magnetically neutral location.

In setting forth this rejection, the Office Action states that “Freeman does not disclose a ‘plurality of magnetic pole pieces’ disposed between two coils” (see page 2, second paragraph, of the Office Action), which feature is recited in claim 24. Accordingly, the Patent Office cites the Kinman patent because, as stated in the Office Action, “Kinman discloses … multiple pole pieces disposed within two coils” (see page 2, second paragraph), which feature is also recited in claim 24. However, the Office Action fails to cite any patent in rejecting claim 24 that suggests positioning a ferromagnetic plate between a pair of coils at a substantially magnetically neutral location.

In view of the foregoing, the limitation of claim 24 of a ferromagnetic plate disposed between a pair of coils at a substantially magnetically neutral location is not shown or described in the Freeman and Kinman patents. In view of the foregoing, it is respectfully submitted that the Freeman and Kinman patents do not render obvious the pickup of claim 24.

Issue B

Claims 28 and 34 stand rejected under 35 U.S.C. § 103(a) in view of the combination of U.S. Patent Nos. 3,657,461 to Freeman; 5,834,999 to Kinman; and 5,811,710 to Blucher et al. These rejections are respectfully traversed.

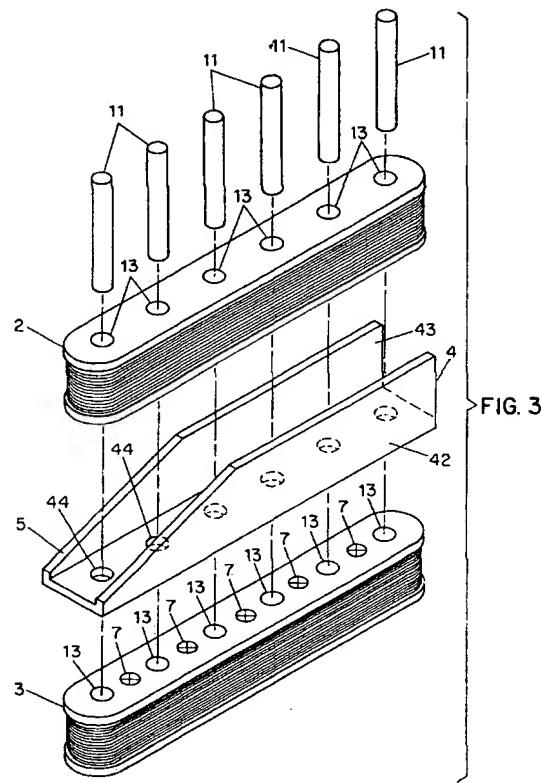
Claims

Focusing on the limitations of claims 28 and 34, the pickup includes a first bobbin about which the first wire coil is disposed and a second bobbin about which the second wire coil is disposed. Claims 28 and 34 depend from claim 24 in which a ferromagnetic plate is disposed between a pair of coils at a substantially magnetically neutral location.

Cited Patents

The Freeman and Kinman patents are described above.

U.S. Patent No. 5,811,710 to Blucher et al. shows a pickup 1 with bobbins 2 and 3, coils 21 and 31, a plate 4, and magnets 11 (see column 3, lines 42–65, and FIG. 3). In contrast to the invention recited in the claims of the subject application, Freeman is silent as to positioning a ferromagnetic plate at a substantially magnetically neutral location between a pair of coils.



Errors in the Rejection

In rejecting claims 28 and 34, the Office Action fails to address the limitation of positioning a ferromagnetic plate at a substantially magnetically neutral location between a pair of coils. Each of the three cited patents fails to teach or suggest this feature of claims 28 and 34.

Therefore, the limitation of claims 28 and 34 of a ferromagnetic plate disposed at a substantially magnetically neutral location between a pair of coils is not shown or described in the combination of the Freeman, Kinman, and Blucher et al. patents. In view of the foregoing, it is respectfully submitted that this combination of patents does not render obvious the pickups of claims 28 and 34.

Issue C

Claims 37–40 stand rejected under 35 U.S.C. § 103(a) in view of U.S. Patent Nos. 3,657,461 to Freeman and 5,811,710 to Blucher et al. These rejections are respectfully traversed.

Claims 37–39

Each of the independent claims 37–39 includes the feature of a ferromagnetic plate disposed at a substantially magnetically neutral location between a pair of coils.

Claim 40

Claim 40 includes the limitation of a providing a pickup with a ferromagnetic plate that is substantially planar over an entire surface thereof.

Cited Patents

The Freeman and Blucher et al. patents are discussed above.

Errors in the Rejection

In rejecting claims 37–40, the Office Action states that “Freeman discloses a planar ferromagnetic plate (2) disposed in a magnetically neutral position between an upper and lower wire coil” (see page 5, first paragraph). However, as apparent from the discussion above, this is an errant assertion in that Freeman is silent as to positioning a ferromagnetic plate between coils at a magnetically neutral position. In addition, Freeman is also silent as to providing a ferromagnetic plate that is substantially planar over an entire surface thereof.

Accordingly, in view of the errant assertion made in the Office Action and by the lack of teaching or suggestion by the cited patents, it is respectfully submitted that this combination of patents does not render obvious the invention as recited in claims 37–40.

Grouping of Claims 37–40

Appellant states that the claims 37–40 subject to this rejection should not stand or fall together. The reason why these claims of this same rejection are separately patentable is that each of claims 37, 38, and 39 includes the limitation of a ferromagnetic plate being disposed between a pair of coils at a magnetically neutral position. Claim 40 does not include this limitation. Therefore, the merits of claims 37, 38, and 39 should be examined separately from the merits of claim 40.

Closing Comments

In view of the foregoing, it is respectfully submitted that the subject application, including claims 24–40, is in condition for allowance. Early notification of the same by the Board is respectfully requested.

Respectfully submitted,



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Dated: February 28, 2005

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9. Appendix A—Claims on Appeal

24. A pickup for a musical instrument, the pickup comprising:
a first wire coil;
a second wire coil disposed proximate the first wire coil;
a plurality of magnet pole pieces disposed at least partially within both the first wire coil
and the second wire coil; and

a ferromagnetic plate substantially planar over an entire surface thereof disposed in a
substantially magnetically neutral location between the first and second wire coils.

25. The pickup as recited in claim 24, wherein the ferromagnetic plate generally
separates magnetic lines of force of a north pole of the magnet pole pieces from magnetic lines of
force of a south pole of the magnet(s).

26. The pickup as recited in claim 24, wherein:
the magnet pole pieces comprise elongated magnets; and
the ferromagnetic plate is oriented substantially perpendicularly with respect to the
magnet pole pieces and is disposed substantially midway between opposite ends thereof.

27. The pickup as recited in claim 24, wherein the ferromagnetic plate comprises a
single, uniformly flat ferromagnetic plate.

28. The pickup as recited in claim 24, further comprising:
a first bobbin about which the first wire coil is disposed; and
a second bobbin about which the second wire coil is disposed.

29. The pickup as recited in claim 24, wherein the first wire coil is disposed generally
above the second wire coil.

30. The pickup as recited in claim 24, wherein the first wire coil and the second wire coil are substantially matched to one another and are oppositely wound.

31. The pickup as recited in claim 24, wherein the ferromagnetic plate does not connect to any ferromagnetic portion that extends upwardly to the elevation of the upper end portions of the magnet pole pieces.

32. The pickup as recited in claim 24, wherein the ferromagnetic plate does not connect to any ferromagnetic portion that extends downwardly to the elevation of the lower end portions of the magnet pole pieces.

33. The pickup as recited in claim 24, wherein the ferromagnetic plate does not connect to any ferromagnetic portion that extends upwardly to the elevation of the upper end portions of the magnet pole pieces and wherein the ferromagnetic plate does not connect to any ferromagnetic portion that extends downwardly to the elevation of the lower end portions of the magnet pole pieces.

34. The pickup as recited in claim 24, further comprising:

a first bobbin having two longitudinal sides, the first wire coil being disposed about the first bobbin;

a second bobbin having two longitudinal sides, the second wire coil being disposed about the second bobbin; and

a pair of steel plates attached to both longitudinal sides of one of the bobbins and extending toward the other bobbin past the ferromagnetic plate and not in physical or electrical contact therewith.

35. The pickup as recited in claim 24, wherein the ferromagnetic plate has a thickness of between approximately 0.125 inch and approximately 0.187 inch.

36. The pickup as recited in claim 24, wherein the ferromagnetic plate has a thickness of at least 0.100 inch.

37. A pickup for a musical instrument, the pickup comprising:
a first wire coil;
a first bobbin about which the first wire coil is disposed;
a second wire coil;
a second bobbin about which the second wire coil is disposed;
a ferromagnetic plate substantially planar over an entire surface thereof disposed in a substantially magnetically neutral location between the first wire coil and the second wire coil; and

wherein the first wire coil and the second wire coil are configured so as to create a humbucking effect.

38. A guitar comprising:
a body;
a pickup disposed upon the body, the pickup comprising:
a first wire coil;
a first bobbin about which the first wire coil is disposed;
a second wire coil;
a second bobbin about which the second wire coil is disposed;
a flat ferromagnetic plate substantially planar over an entire surface thereof disposed in a substantially magnetically neutral location between the first wire coil and the second wire coil; and

wherein the first wire coil and the second wire coil are configured so as to create a humbucking effect.

39. A method for forming a pickup for a musical instrument, the method comprising:
providing a first wire coil positioned on a first bobbin;
providing a second wire coil positioned on a second bobbin;
providing a ferromagnetic plate configured to be substantially planar over an entire surface thereof; and

assembling the first wire coil, the second wire coil and the ferromagnetic plate such that the ferromagnetic plate is disposed in a substantially magnetically neutral location between the first wire coil and the second wire coil.

40. A method for converting vibrations of strings of a musical instrument into electrical signals representative thereof, the method comprising:

providing a pickup comprising a ferromagnetic plate substantially planar over an entire surface thereof disposed between two wire coils, each coil positioned on a bobbin;
causing at least one string to vibrate so as to vary current in the two wire coils; and
humbucking the two coils so as to mitigate noise therefrom.

9. Appendix B—Specification of Published Application

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This is a continuation-in-part of U.S. patent application Ser. No. 09/014,839, filed Jan. 28, 1998, for a Pickup for Electric Guitars.

BACKGROUND AND SUMMARY OF THE INVENTION

[0002] It is generally recognized that some of the most famous solid-body electric guitars have their own “sound”, and that this “sound” differs from that generated by many other such guitars.

[0003] It is also recognized that the “sound” created by a solid-body electric guitar is determined primarily by its pickups (transducers).

[0004] Accordingly, there has long been a strong inclination for the manufacturers of famous, successful solid-body electric guitars to make little or no changes in their pickups.

[0005] However, it is also a fact that “noise” sensed by the pickups can seriously adversely affect a performance by a guitarist, or a practice session, etc. Noise, such as that resulting from electromagnetic radiation, has been recognized as being a major problem since almost the time when the electric guitar became popular.

[0006] It is therefore an object of the present invention to provide a pickup and method such that the manufacturer can duplicate the “sound” of one or more classic (or other) solid-body guitars, and at the same time achieve effective and practical reduction or elimination of noise.

[0007] The present invention in one of its aspects has symmetrically balanced coils arranged in a concentric (coaxial) configuration, with a ferromagnetic plate having certain characteristics and which is centrally common to both coils; it incorporates the humbucking pickup principle in a way that achieves maximum noise immunity.

[0008] The efficiency of the transducing of string vibrations to achieve a strong signal at the pickup is an additional important criterion of a great pickup. There is in the present pickup an improved construction and method for increasing the magnetic flux through the coils of the

pickup, and near the vibrating strings, and which correspondingly increases the output voltage and signal amplitude of the pickup.

[0009] There is, in accordance with another aspect of the invention, an improved construction and method for adding or subtracting inductive components to enhance the sound and tonal characteristics of the pickup, without compromising noise immunity.

[0010] There is improved incorporation and location of pole pieces of varying lengths in the pickup to control the output, balance, and sensitivity for different diameter musical strings.

[0011] There is in the present invention improved isolation between the pickup coils to reduce phase cancellation of common frequencies, which allows the pickup to exhibit an improved harmonic content and thus richer sound and tonal quality.

[0012] In accordance with another aspect of one or more embodiments of the invention, the ferromagnetic plate serves also as a part of the bobbin for the coil, to achieve added compactness and alter the induction and the sound.

[0013] In accordance with yet another aspect of the invention, a pickup is provided herein that includes a pair of steel or ferromagnetic plates attached to the longitudinal sides of a lower bobbin. The plates preferably extend upward pass the lower coil and central ferromagnetic plate. A thin electrical insulator may separate the side plates from the central ferromagnetic plate to prevent an electrical connection between both elements. The plates concentrate the electromagnetic fields produced by the permanent magnetic pole pieces around both coils to achieve a more efficiently produced voltage at the pickup connections.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a top plan view of an electromagnetic pickup embodying the present invention;

[0015] FIG. 2 is a view, the right half of which is in side elevation and the left half of which is in vertical central section, of the pickup;

[0016] FIG. 3 is an end elevation as viewed from the right in FIG. 1, the coils being unshown;

[0017] FIG. 4 is an isometric view of the pickup, and showing the side thereof opposite that shown in FIG. 1;

[0018] FIG. 5 is an exploded isometric view of the pickup, the left end of such view corresponding to the top of the pickup;

[0019] FIGS. 6 and 7 are a top plan view and a side elevation of a pickup employing the invention for a different guitar than the one for which the pickup of FIGS. 1-5 is constructed;

[0020] FIGS. 8-11 illustrate, by example, top, front, side and blow-up views of a pickup in accordance with another aspect of the invention; and

[0021] FIG. 12 illustrates, by example, a perspective view of a guitar in accordance with yet another aspect of the invention.

DETAILED DESCRIPTION

[0022] The present invention is incorporated in an electric guitar, typically a solid-body electric guitar, such as is shown in U.S. Pat. No. 2,972,923 for a Floating Tremolo and Bridge Construction for Lute-Type Musical Instruments, inventor C. L. Fender. Said patent is hereby incorporated by reference herein.

[0023] The word "guitar", as employed in the present specification and claims, denotes any electric guitar, electric bass (electric bass guitar), etc.

[0024] The pickups shown in the drawings are for six-string guitars. However, the number of strings (and thus the pickups) may vary.

[0025] Each of the pickups shown in the drawings is symmetrical about a vertical plane that is perpendicular to the longitudinal axis of the pickup and that is midway between the ends of the pickup.

[0026] Referring to FIGS. 1-5, the core assembly of the pickup comprises an upper bobbin section, a centrally located ferromagnetic steel plate, and a lower bobbin section. Fastening screws, of ferromagnetic material, are inserted upwardly through the bobbin core at the base of the lower bobbin section. The central steel plate is provided with corresponding small apertures to receive the screws. The screws pass through apertures in the plate, the apertures in the plate

being of a greater diameter than the major diameter of each screw. The plate engages the upper planar surface of the lower bobbin section.

[0027] The upper bobbin section engages the plate at the lower planar surface of the upper bobbin section. The screws are then fastened into the upper bobbin section, coupling the upper and lower bobbin sections together with the plate interposed between the upper face section of the lower bobbin and the lower face section of the upper bobbin.

[0028] Each bobbin section has a plurality of circular (cylindrical) apertures which extend and align through the central cores of the upper and lower bobbin sections to receive a plurality of corresponding rod-type permanent-magnet (magnetic) pole pieces. The plate has a plurality of corresponding circular apertures which align with the circular apertures (which receive the permanent-magnet pole pieces) in the upper and lower bobbin sections.

[0029] The circular apertures in the plate have additional small apertures adjacent to the described circular apertures, for the purpose of receiving additional ferromagnetic steel pole pieces (slugs).

[0030] The illustrated permanent-magnet (magnetic) pole pieces are of sufficient length to extend fully through the upper and lower bobbin sections.

[0031] The illustrated permanent-magnet (magnetic) pole pieces are flush at the base of the lower bobbin and extend upwardly through the upper bobbin. The illustrated magnets project a short distance above the upper bobbin surface, being positioned above the upper bobbin surface in an echelon arrangement.

[0032] To further describe the pickup shown in drawing FIGS. 1-5, it comprises an upper bobbin 10, a lower bobbin 11, six permanent-magnet pole pieces 12, screws 13, upper and lower coils (windings of wire) 14 and 15, and a ferromagnetic steel plate 17.

[0033] Upper bobbin 10 and lower bobbin 11 are formed of nonmagnetic and nonmagnetizable material, preferably a synthetic resin that is an electrical insulator. Upper bobbin 10 has upper and lower parallel plates between which the upper coil 14 is wound in a particular direction, for example clockwise as viewed from above. The lower plate is longitudinally slotted. Lower bobbin 11 has upper and lower plates also parallel to each other,

the upper plate in the preferred form being longitudinally slotted and being much larger than the lower, and forming a skirt which is used for mounting purposes. The lower coil 15 is wound in lower bobbin 11 in a direction opposite to said above-indicated particular direction, for example counterclockwise as viewed from above. The coils are parallel to each other.

[0034] The upper and lower plates of upper bobbin 10 are numbered 18 and 19, respectively. The skirt plate and lower plate of lower bobbin 11 are numbered 20 and 21, respectively. The cores of the upper and lower bobbins are numbered 22a and 22b, respectively.

[0035] The six permanent-magnet pole pieces, 12a, 12b, 12c, 12d, 12e, 12f, are mounted parallel to each other in the registered apertures (holes) in upper and lower bobbins 10 and 11, as shown. The magnetic poles of the pole pieces correspond to each other. Thus, for example, all of the north poles are uppermost and all of the south poles are lowermost. For simplicity, and without limitation, this north-pole-uppermost convention is used throughout the present specification and claims.

[0036] The ferromagnetic screws 13 are mild steel screws. They not only hold the bobbins together with each other and with the ferromagnetic steel plate, but also alter the inductance of the pickup. Thus, they serve two purposes.

[0037] The indicated holes 23 (for the slugs) are between pole pieces 12b and 12c, and 12d and 12e.

[0038] There are electrical connections (FIG. 1) 27,28,29 and 30. Two of these serve the upper coil 14, and the other two serve the lower coil 15. The electrical connections at 27-30, inclusive, are such that coils 14 and 15 are series connected in opposition to each other. Because the lower winding is wound in a direction opposite the upper, the humbucking effect is achieved.

[0039] The ferromagnetic steel plate 17 is (as above stated) sandwiched between plates 19 and 20 and parallel thereto. The permanent-magnet pole pieces are perpendicular to plate 17.

[0040] Ferromagnetic cylinders are inserted in the holes 23 in order to change the inductance of the pickup. These may be changed in accordance with the desires of the musician. There may be cylinders in some holes 23 and not in others.

[0041] The permanent-magnet pole pieces **12** are preferably mounted in their respective bobbin holes by friction—the friction being sufficiently strong that the magnets **12** will not move accidentally but can be adjusted when desired so as to be nearer to or farther from the guitar strings. This is done at the factory. Each magnet **12** may also be manufactured somewhat longer or shorter. The results are controlled output, balance and sensitivity for different diameter musical strings.

[0042] Further Description of the Pickup and of the Method of Transducing the Vibrations of Guitar Strings

[0043] The magnets **12** (permanent-magnet pole pieces) are caused to be highly elongate—sufficiently so that they extend (as above mentioned) through both of the coils **14,15** and through the ferromagnetic plate **17**. This despite the fact that plate **17** is thick, as described below.

[0044] There is a substantially magnetically neutral zone substantially midway between the north pole of each magnet and the south pole thereof. The ferromagnetic plate **17** is oriented substantially perpendicular to magnets **12** and substantially midway between opposite ends of the magnets. Thus, the plate **17** is intentionally located in the magnetically neutral zones of magnets **12**.

[0045] In addition, the plate **17** is intentionally caused to be sufficiently thick that (1) the upper portion thereof (nearest the guitar strings) contains lines of magnetic force from the north poles, while the lower portion thereof contains lines of force from the south poles, and (2) such upper portion contains few or no lines of force from the south poles, while such lower portion contains few or no lines of force from the north poles. There is accordingly a magnetic separation between the magnetic fields in the upper and lower portions of plate **17**.

[0046] The ferromagnetic plate **17** is preferably made of mild steel; it is caused to be at least 0.100 inch thick. Preferably, it is at least 0.125 inch thick. Its thickness is in a range of about 0.125 inch to about 0.187 inch. Instead of one thick plate, there may be a stack of thin ferromagnetic sheets (the word plate, etc., used herein relative to the ferromagnetic plate, denotes also this stacked relationship).

[0047] Because of the above-stated factors, lines of magnetic force extend upwardly in large numbers from the north poles to the zones where the strings vibrate. The lines are not bent downwardly by ferromagnetic elements or portions located relatively near the strings. It follows that there is strong interaction between the strings and the magnetic fields, with consequent strong electrical signals.

[0048] Lines of force bend downwardly from the regions of the strings, pass through upper coil 14, and pass into the upper portion of plate 17 as above described. The lines passing through the upper coil are particularly effective in signal generation.

[0049] The plate 17 effectively separates the upper coil 14 from lower coil 15. Stated in another manner, the string vibrations are sensed very largely by upper coil 14 not lower coil 15. It follows that there is little or no cancellation of musical frequencies and harmonics by the oppositely-connected coils, so that strong musical electrical signals are achieved.

[0050] On the other hand, electromagnetic radiation and other noise-generating phenomena are sensed substantially equally by both coils and accordingly cancel each other out. The result is effective noise reduction.

[0051] It is emphasized that the illustrated pickups incorporate balanced (and matched) coils above and below the plate 17. There are substantially the same number of wire turns, wire size, etc., above and below the ferromagnetic plate.

[0052] It is emphasized that by putting the thick plate 17 in the stated magnetically neutral position, more lines of force are caused to pass through upper coil 14. This increases signal strength and efficiency of signal generation.

[0053] Lines of force are saturated substantially all the way through the upper coil 14 and the lower coil 15, but separately. Thus, the lines in the upper coil are from the north poles and those in the lower coil are from the south poles. This achieves excellent humbucking action, especially since the coils are matched, balanced, to each other.

[0054] Proceeding next to a further description of the adjusting of the inductance of the pickup, it is emphasized that the inductance is initially determined by such factors as number of turns of wire in the coils, physical coil size, coil shape, size and shape of ferromagnetic plate 17,

etc. These and other factors are carefully made such that the pickup achieves substantially the desired tonal and other characteristics ("sound"). In accordance with one aspect of the present invention, elements are provided that make it possible and practical to adjust the inductance of the pickup after it has been initially manufactured.

[0055] The above-indicated holes 23 in upper and lower bobbins 10,11 are elongate, being oriented perpendicular to ferromagnetic plate 17. Preferably, holes extend from the outer bobbin surfaces down (and up) to plate 17, as shown in FIG. 2.

[0056] In the pickup shown in FIGS. 1-5, there are four holes 23, namely two in each bobbin 10,11. Two of such holes are aligned with each other, being disposed between magnets 12b,12c on opposite sides of plate 17. Correspondingly, the remaining two holes 23 are disposed between magnets 12d,12e on opposite sides of plate 17, the holes being aligned with each other.

[0057] The above-indicated ferromagnetic cylinders, or slugs, are numbered 31-34, inclusive, being elongate mild steel cylinders. Cylinders 31-34 are illustrated in FIG. 5.

[0058] To facilitate mounting and adjustment of cylinders 31-34 in their respective holes 23, the holes are made square in cross-section; the walls of the holes frictionally hold the steel slugs.

[0059] The above-described screws 13, being ferromagnetic (mild steel), cooperate with slugs 31-34 in achieving desired adjustments of the inductance of the pickup. As shown in FIGS. 1, 2 and 5, the screws are respectively located between magnets 12a-12b, and 12e-12f. Screws 13 perform the double functions of maintaining the pickup assembled, and cooperating in varying the inductance.

[0060] To change the inductance, the cylinders (slugs) 31-34 are changed in positions, sizes (slug lengths), etc. Slugs may be mounted in some holes 23 and not others. The screws 13 may also be changed, as by employing one or both screws that are not ferromagnetic.

[0061] Description of the Pickup of FIGS. 6-7, Inclusive, and of an Additional Way to Achieve Desired Inductance

[0062] In the pickup of FIGS. 1-5, each coil is somewhat spaced from the ferromagnetic plate 17. Thus, as best shown in FIG. 5, upper coil 14 is spaced from plate 17 by the thickness of

insulating plate 19. Lower coil 15 is spaced from plate 17 by the thickness of insulating skirt plate 20 at the region thereof that contacts plate 17. Such region is quite thin, because the skirt plate is recessed at 36 (FIG. 5) to snugly receive the lower portion of plate 17. The stated spacing of the coils 14,15 from plate 17 is a factor in determining the inductance of the pickup, and the sound that the pickup puts out.

[0063] Referring next to FIGS. 6 and 7, a second pickup is shown. Except as specifically stated below, this second pickup is constructed identically to the pickup of FIGS. 1-5.

[0064] The upper and lower matched (except for direction of winding) humbucking coils 37 and 38 are each thick, in comparison to the coils of the pickup of FIGS. 1-5. Furthermore, the number of turns of wire, and other factors, are made different (in comparison to the pickup of FIGS. 1-5), all for the purpose of achieving the desired sound for a different guitar model than the model incorporating the pickup of FIGS. 1-5.

[0065] The ferromagnetic plate 17a sandwiched between the coils is not spaced therefrom, but instead engages one and normally both (as shown). Thus, the coils 37,38 are very close to the plate 17a, in contact therewith, but there is no electrical connection between plate and coils because a suitable coating (or coatings) is provided in order to achieve electrical insulation. Also, a thin paper, etc., may be used between the plate and each coil.

[0066] With the described construction, the upper bobbin 39 is only a half bobbin, having only an upper side 42 from which extends downwardly the insulating bobbin core portion that is within coil 37. Except for dimensions, the construction corresponds to that illustrated at the left in FIG. 5 relative to the upper bobbin plate 18 and connected core 22a.

[0067] Correspondingly, in the pickup illustrated in FIGS. 6 and 7, the lower bobbin 43 has no plate or flange adjacent ferromagnetic plate 17a. Instead, it has a lower bobbin plate/skirt plate 44 that is large in size and has thereon the electrical connection elements 45 that are used to make the opposing connection between the reverse-wound humbucking coils 37,38.

[0068] Bobbin plate/skirt plate 44 is connected to an insulating core corresponding (except for dimensions) to that, numbered 22b, shown at the right in FIG. 5. The ferromagnetic screws hold the cores against opposite sides of plate 17a.

[0069] Description of the Pickup of FIGS. 8–11 and of an Additional Way to Achieve Desired Inductance

[0070] FIGS. 8–11 illustrate, by example, an additional embodiment of a guitar pickup 50 in accordance with yet another aspect of the invention. Specifically, FIG. 8 depicts a top, plan view of the pickup 50, FIG. 9 is a front elevation view of the pickup, FIG. 10 depicts a side elevation view of the pickup, and FIG. 11 illustrates a blow-up view of a central section of the pickup shown in FIG. 10. The pickup 50 may be similarly constructed as per either pickups of FIGS. 1–7, but includes an additional feature described below. Accordingly, the pickup 50 includes an upper bobbin 52, a lower bobbin 54, a ferromagnetic steel plate 56, an upper coil 58, a lower coil 60, and a plurality of permanent-magnet pole pieces 62, which are similarly configured as either of the embodiments shown in FIGS. 1–7.

[0071] The pickup 50 further includes a pair of thin plates 64 preferably having respective lower portions attached to at least the front and rear side of lower bobbin 54. The plates 64 extend upward from the lower bobbin 54 above the lower coil 60 and ferromagnetic steel plate 56. As better shown in FIG. 11, the plates 64 do not make an electrical connection with the ferromagnetic steel plate 56. In the preferred embodiment, a thin electrical insulation material 66 is positioned between the plates 64 and the ferromagnetic steel plate 56 to prevent an electrical connection between both elements. The purpose for electrically insulating the side plates 64 from the ferromagnetic steel plate 56 is to prevent coupling of the poles of the permanent magnet pole pieces 62 to the side plates 64. The plates 64 can also be configured to be spaced apart from the ferromagnetic steel plate 56 without the use of the insulator 66. Also, in the preferred embodiment, the thin plates 64 are formed of steel material, but it shall be understood that other ferromagnetic materials can be used for these plates.

[0072] The purpose of the steel plates 64 is to concentrate the electromagnetic fields generated by the permanent-magnet pole pieces 62 around the coils 58 and 60 of the pickup 50. The concentrated electromagnetic fields around the coils 58 and 60 increase the coupling between the electromagnetic sensing of the string vibration and the voltage produced at the pickup electrical connection. This results in a more efficient generation of voltage at the coil ends or electrical connections of the pickup 50.

[0073] FIG. 12 illustrates, by example, a perspective view of a solid-body electric guitar 70 in accordance with another aspect of the invention. As typical of most guitars, the guitar 70 comprises a body 72, a neck 74, a head 76, a string-holding plate 78, bridge 80 and strings 82. The strings 82 are attached at one end to plate 78 and at the other end to tuning pegs situated on the head 76 of the guitar 70. The steel strings 82 are supported by the bridge 80 and the interface between the neck 74 and the head 76 in a tension fit, as customary of most guitars. The guitar 70 includes at least one pickup 86, and preferably two, of the type described herein and illustrated in FIGS. 1–11. The pickups 86 are preferably mounted on the body of the guitar, preferably situated within a pair of registered apertures (not shown) formed within the body between the bridge 80 and the neck 74. The permanent-magnetic pole pieces of the pickups 86 are preferably situated below and substantially aligned with the strings 82 of the guitar 70, so that the pickups can sense the vibration of the strings during play.

[0074] Although a solid-body electric guitar 70 is used to illustrate this aspect of the invention, it shall be understood that the pickups described herein can be used on any type of guitar, including acoustic guitars, as long as the guitars have electromagnetic interacting strings, such as steel strings. The pickups 86 need not be situated into registered apertures formed through the body of the guitar 70, but can be positioned anywhere on the guitar so that they electromagnetically interact with the strings. Other configurations of guitar exist in addition to the one disclosed in FIG. 12, that one skilled in the art can configure so that the pickups can sense the vibrations of the strings during play.

[0075] Summary of the Method

[0076] In accordance with the method of the invention, an electric guitar is provided having a plurality of substantially parallel and adjacent tensioned strings formed (typically) of steel. An elongate permanent-magnet pole piece is mounted near each string but spaced therefrom to permit string vibration. Such magnets extend generally parallel to each other, in generally a single plane, in a direction away from the strings. The polarity of each magnet is the same as all the others, all north (for example) poles being nearest the strings and all south poles being remote therefrom.

[0077] Substantially matched and balanced coils are provided, having generally the same number of turns of fine wire. Each coil is mounted around the magnets, so that one coil is relatively "near" the strings and the other coil is relatively "far" from them. The coils are substantially concentric. They are wound in opposite directions relative to each other, and are connected to each other in series-circuit relationship and in opposition to each other, so as to be humbucking.

[0078] A thick ferromagnetic plate is mounted between the stated "near" and "far" coils. The plate has the characteristics stated above relative to plate 17.

[0079] Lines of magnetic force from the north poles emanate from the north poles of the magnets, extend upward to the near strings for interaction therewith, and pass downward through the "near" coil to and through the region of the plate nearest the strings. From there they extend back up to the north pole, many passing near the strings.

[0080] The lines of force from the north poles are not caused to pass through ferromagnetic portions or elements located relatively near the elevation of the magnet end portions that are nearest the strings. Thus, the lines of force do not bend relatively sharply downwardly but instead pass near the strings.

[0081] Lines of force emanate from the south poles, then extend toward the strings through the "far" coil. The lines enter the ferromagnetic plate, in the portion thereof that is relatively far from the strings. They pass back down to the south poles.

[0082] When the strings are caused to vibrate, there is strong transducing interaction with the lines of force from the north poles. This, and the interaction with the "near" coil, generates strong musical signals; these are conducted to electrical amplifier means. There is little or no interaction with the "far" coil.

[0083] The "near" coil and the "far" coil, and the magnets and their lines of force, interact substantially equally with extraneous electromagnetic signals and other noise. This creates corresponding noise signals that substantially cancel each other.

[0084] While the invention has been described in connection with various embodiments, it will be understood that the invention is capable of further modifications. This application is

intended to cover any variations, uses or adaptation of the invention following, in general, the principles of the invention, and including such departures from the present disclosure as come within known and customary practice within the art to which the invention pertains.